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THE USES OF ALFALFA

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ALFALFA is the most important forage crop in the United States. In 1938 there were 13,462,000 acres, which produced 28,858,000 tons of hay in addition to seed and some pasturage.

Alfalfa should be cut when one-tenth to one-half in bloom or when the foliage takes on a yellowish cast indicative of the slowing up or stopping of growth. Yields are larger when cutting is delayed until the plants are in full bloom, but this is at some sacrifice in the feeding value of the hay. To avoid loss of leaves, hay should be raked as soon as it is well wilted and the curing completed in small loose windrows. The ideal storage place is the barn or shed. Stacks should be fairly large and well-built to reduce the losses to a minimum. Under humid conditions stacks should be covered. Alfalfa hay is equal if not superior in feeding value to hay made from any other crop.

As a pasture crop, alfalfa must be grazed with care to avoid injuring or destroying the stands. Cattle and sheep are likely to bloat on alfalfa pasture. This is not true of other animals. Hogs do exceedingly well on alfalfa pasture and are less likely than other animals to injure the stands.

Although not an ideal silage crop, alfalfa is being used as silage to an increasing extent. There is less danger of spoilage when the alfalfa is mixed with corn, sorghum, or molasses, or when the acidity is reduced to below pH 4 by adding acids.

The straw that is left after threshing a seed crop is generally considered worth one-third to one-half as much as alfalfa hay for feeding purposes.

About 400,000 tons of alfalfa meal of various kinds is produced each year. The hammer mill is most generally used in pulverizing alfalfa. Four types of ground alfalfa are produced—chopped alfalfa, alfalfa meal, alfalfa-leaf meal, and alfalfa-stem meal. The feeding value of alfalfa is not increased by grinding. The advantages of the meal are that it is fed with less loss than the hay and the shipping charges are less. Most of the alfalfa meal produced at the present time is used by the mixed-feed industry as one of the constituents of the various types of manufactured feeds, the feeding value of which is dependent upon their ingredients.

In recent years considerable interest has developed in dehydrated alfalfa because of its higher protein and carotene content.

The uses of alfalfa, particularly as a forage crop, are set forth in this bulletin, and suggestions are offered that may be helpful in making its utilization more efficient and more generally satisfactory.

This bulletin is a revision of and supersedes Farmers' Bulletin 1229, Utilization of Alfalfa.

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THE USES OF ALFALFA

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Contents

A NEARLY PERFECT FORAGE

NO OTHER forage crop cultivated in the United States gives satisfaction in as many ways as alfalfa. It is more nearly a perfect forage than any other crop grown in this country. As hay, it is unsurpassed for general feeding. As pasture, it has a high carrying capacity and produces large gains. As a soiling crop, it is valuable with proper handling. It makes excellent silage when properly handled and is a good feed when chopped or ground into meal. In addition to its energy content alfalfa is a valuable source of carotene, riboflavin (vitamin G), protein, and calcium; hence the contribution of alfalfa to a diet will depend upon the general character of that diet.

Alfalfa is not only valuable as a forage crop but also produces a favorable effect on the succeeding crop; because of this it is generally regarded as a soil improver.

Alfalfa is also used to a limited extent as a human food, but there is relatively little information as to its value for this purpose.

IMPORTANCE OF ALFALFA

Alfalfa is the most important forage crop in the United States (fig. 1). In 1919 one-eighth of the total hay acreage was alfalfa, and by 1938 it occupied over one-fifth of the total acreage. In 1938 alfalfa was grown on 13,462,000 acres, which produced 28,858,000 tons of hay. Most of the alfalfa grown is made into hay, although small acreages are pastured and used for seed. Much of the pasturing

is done on acreage from which at least one crop of hay has been harvested during the year. In the Southwest many sheep and cattle are carried through the winter on the pasturage supplied by the alfalfa fields. Prior to their removal to winter range in the desert, many sheep in the Intermountain States are pastured for a short time on the alfalfa stubble in the fall. No estimate, however, is available on the percentage of alfalfa acreage used for pasture.

The average acreage of alfalfa harvested for seed from 1927 to 1936 was 463,690. This does not materially affect the total alfalfa acreage, because in most cases hay is harvested from the same acreage before or after the seed crop is produced.

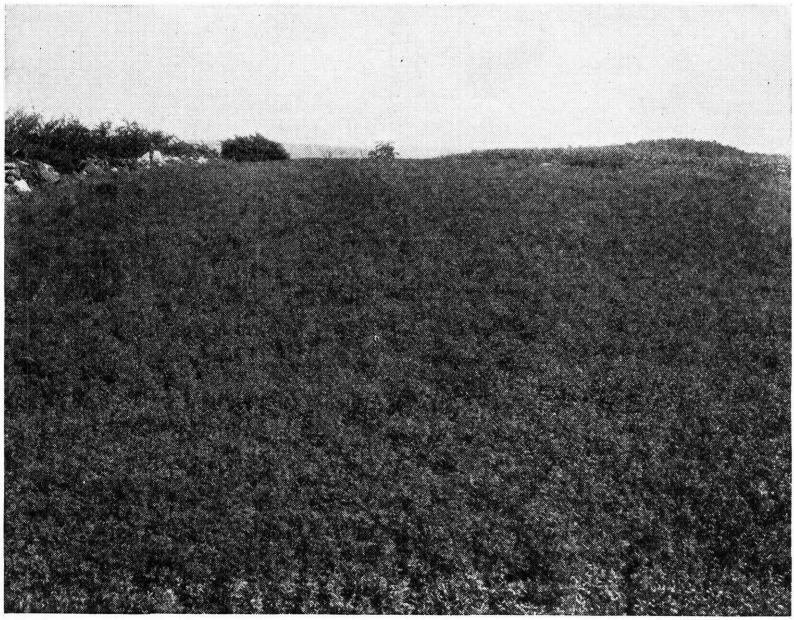

FIGURE 1.—A good stand of alfalfa. Leafy, fine-stemmed alfalfa, free from weeds and other hay plants, is produced on stands of this kind.

Most of the alfalfa hay is fed as long hay, cattle probably consuming the larger proportion, although in some areas in the West it is used exclusively to feed all types of livestock.

The proportion of alfalfa hay used in the production of alfalfa meal is not large. Reports received by the Department of Agriculture indicate that an average of 270,000 tons of alfalfa meal was produced in the crop years 1933–34 to 1937–38, which probably represents about 75 percent of the total meal production, since reports were not received from all producers of meal.

MAKING ALFALFA HAY

The number of cuttings obtainable from a field of alfalfa in a year depends on the variety and the length of the growing season and varies from six, or occasionally more, in the extreme Southwest, to two, or sometimes only one, in the northern and semiarid sections.

From 30 to 40 days of good growing weather are usually required to produce sufficient growth for a hay crop.

TIME OF CUTTING ALFALFA

The stage of growth at which alfalfa is cut has a direct bearing on the yield and quality of the hay and the life of the stand. Early-cut hay is higher in feeding value than late-cut hay, because of the greater proportion of leaves, which contain at least twice as much protein as the stems (fig. 2). The stems of late-cut hay are usually hard and woody, which makes them objectionable as feed for certain classes of livestock. Continued cutting over a period of years as early as the bud stage has been shown repeatedly to result in lower yields and to shorten the life of a stand. Where cutting is delayed until the plants

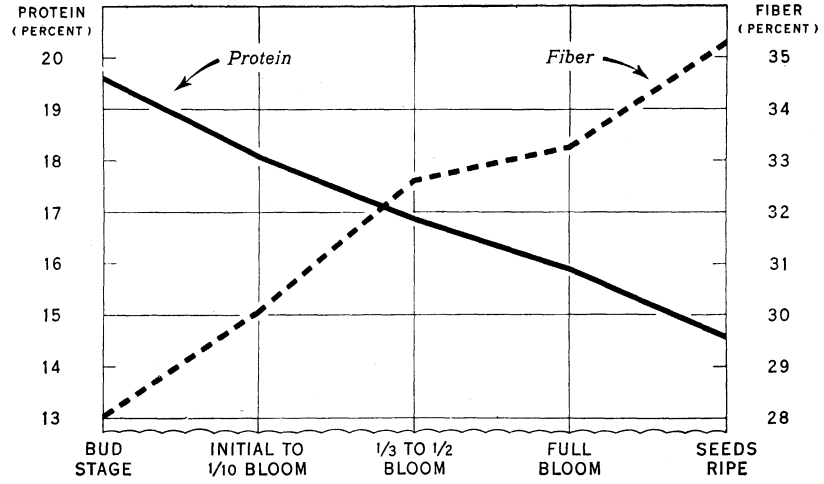

FIGURE 2.—Protein and fiber content of alfalfa cut at different stages of growth. Alfalfa hay cut early has the highest protein and the highest feeding value, and there is a uniform decrease in protein and increase in fiber as the plant becomes more mature.

are in full bloom, stands survive longer, and yields usually are larger, but this is at the expense of the feeding value of the hay.

Recent experiments indicate that under certain conditions the first or the first and second growth may be removed at the bud or early-bloom stage without shortening the life of the stand, provided one or more of the later cuttings are left until nearly full bloom. By following this practice it is possible to obtain a better quality of hay from the early growth, which is generally rank and coarse, if allowed to stand until well in bloom. The main objection to early-spring cutting is that the weather conditions at that time are more apt to be unfavorable for curing. Whether one or more cuttings are removed at the early stage of growth will depend on the total number of cuttings obtained during the season.

It has usually been recommended that alfalfa be cut at the one-tenth to one-half bloom stage. In the East, however, alfalfa often blooms so sparingly during very wet or very dry seasons that the amount of bloom is not a dependable guide to the stage of maturity.

When this occurs the growth of the basal shoots, or, better still, the general appearance of the field, is the most dependable indication of when the alfalfa should be cut. If the basal shoots have made considerable growth and if the foliage is beginning to take on a yellowish cast indicative of the slowing up or stopping of growth, the crop should be cut regardless of the percentage of bloom. Extensive experiments in Ohio on time and number of cuttings have demonstrated that a system of calendar dates, carefully interpreted for seasonal weather conditions, is more satisfactory than any other system for determining when to make the various cuttings. In some instances attempts have been made to make the cuttings at a time when it would have the greatest effect on reducing the amount of damage from potato leafhoppers.

Under most conditions, and particularly where winters are severe, alfalfa should be permitted 10 or 12 inches of top growth in the fall to enable it to store up an abundance of reserve food in the roots to carry the plants through the winter and to start vigorous growth in the spring. When alfalfa is cut late the food reserves are exhausted in producing new growth, and the plants enter the winter in a weakened condition. If the hay is badly needed, less injury to the alfalfa will result if the growth is not removed until cold weather prevents subsequent growth and resultant depletion of the root reserves.

CURING ALFALFA

The methods of curing alfalfa for hay vary considerably in different parts of the country, depending on local climatic conditions. The aim is to reduce the moisture content of the alfalfa to 20 to 25 percent, so it will keep when placed in storage. The curing should be done so as to avoid loss of a large proportion of the leaves or green color. In most cases the best way to do this is to permit the hay to become well wilted in the swath and then complete the curing by raking it into small, loose windrows. Air circulates freely through such windrows, thus aiding in the curing and limiting the excessive sun bleaching that results from curing the hay entirely in the swath. In this method of curing, the windrows made with a side-delivery rake are more satisfactory than those made with a sulky rake, because they are smaller and less compact. The loss of leaves is reduced because the hay is raked before the leaves have become dry enough to shatter, and green color is also preserved because less hay is exposed to the sun.

Where the sweep rake is used for moving hay to the stack, the hay is usually bunched from the windrows with a sulky rake. In the East it is not usually advisable to bunch the hay, because to do so prolongs the curing period and increases the danger of damage from weather. Farmers often make the mistake of cutting more hay than can be raked and stored, with the machinery and crew available, before it becomes overdried or damaged by weather. If hay is exposed to unfavorable weather for several days the damage will be about the same whether it is in the swath or windrow.

Various forms of curing frames, tripods, and curing trucks have been tried, especially in the South, but in all cases additional labor and cost are involved, and the economy of using them has been found to be questionable. Generally dependence should be placed on quick curing in the swath and windrow rather than on these devices.

Several methods of moving the hay from the field to storage are in use in the different alfalfa areas. Among these are the following: Stacking from the windrow, bunched windrow, or cock with sweep rakes or sleds; loading wagons from the windrow with the hay loader or by hand, and hauling to barns or stacks where the hay is unloaded by means of slings or forks; or baling direct from the windrow with stationary or pick-up baler. Usually a farmer adopts the practice that is most satisfactory under the conditions of hay production obtaining in his particular district.

STORING AND STACKING

The ideal storage place for alfalfa hay is in a barn or shed with a good roof. Hay stored under such conditions will not be damaged by rain or snow during the storage period. It has been estimated that

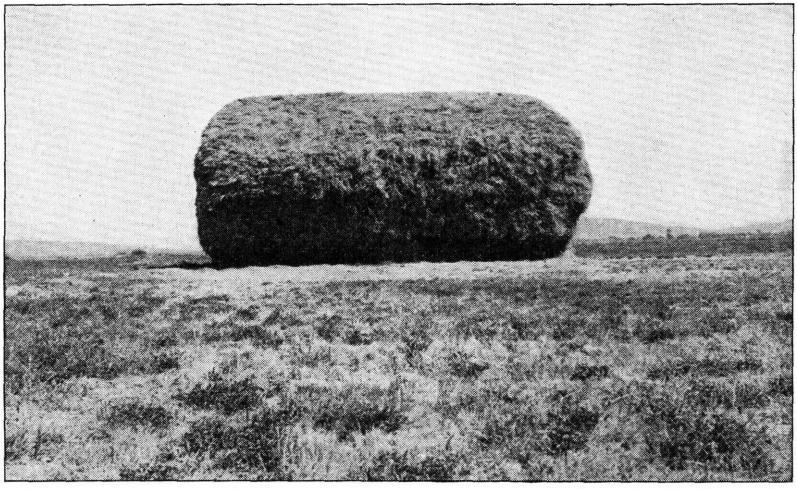

FIGURE 3.—A well-built alfalfa haystack. Losses from unfavorable weather conditions during the storage period are reduced to a minimum in this type of stack.

loss while in storage will be 10 percent greater for hay stored in stacks than for that stored in barns. Some of this loss can be eliminated, however, by building large stacks, by greater care in stacking, and by proper covering.

In the semiarid and arid sections of the West the losses due to weathering while in storage are much less than in more humid sections. In most of this territory large, well-built stacks are made that successfully withstand wind and rain (fig. 3). In Washington and California a few districts are found where carelessly built stacks are made and where the stacks are built in benches that permit rain to penetrate at the point where the benches come together, thus causing considerable damage to the stacked hay. Even in the most favorable areas, from a climatic standpoint it pays to build a good stack in order to reduce spoilage of hay.

Under humid conditions much greater care must be given to the building of stacks, otherwise the loss will be heavy. As spoilage is proportionately less in large stacks than in small ones, the stacks

should be made as large as possible with the equipment available. The saving involved will ordinarily justify the additional cost of a protective covering, such as waterproof paper, canvas, or corrugated

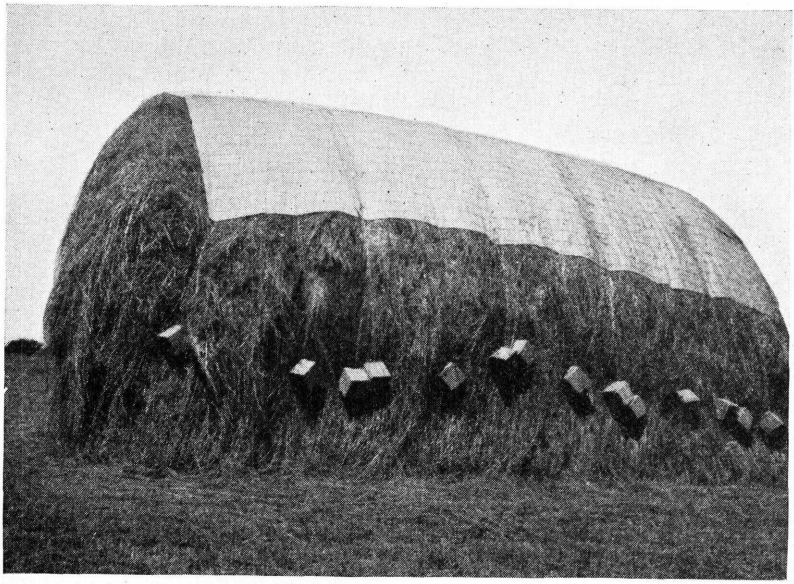

FIGURE 4.—A well-covered stack of alfalfa hay. In stacking alfalfa under humid conditions the saving resulting from a good cover will ordinarily justify the additional expense involved.

sheet iron (fig. 4). When such protection is not available in humid areas the stacks should be covered with grass hay, which ordinarily sheds water more readily than alfalfa. Stacked hay should not be covered with sheet iron or similar material until after it has gone

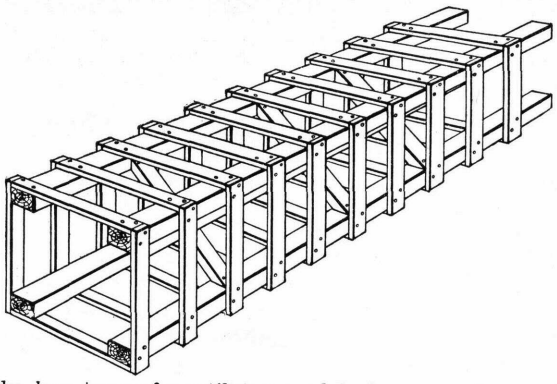

FIGURE 5.—The box type of ventilator used in haymows lessens the danger of spontaneous combustion.

through the sweat, because of the tendency for moisture to condense on the lower side of the cover during that period.

Alfalfa with too high a moisture content should not be stacked or put in the barn, as it is likely to heat and in extreme cases to burn.

Alfalfa, in common with other legume hays, has a greater tendency to heat in storage than the grass hays. The danger from spontaneous combustion, however, can be minimized by the use of a boxlike ventilator, such as that shown in figure 5. This ventilator is 12 to 15 inches square and may be of any desired length. The corners are 2 by 4's and the crosspieces 1 by 3's placed close enough together to keep the hay from falling through and blocking the air passage. Braces are placed at intervals to prevent the box from collapsing under the pressure of the hay. The ventilators are usually placed

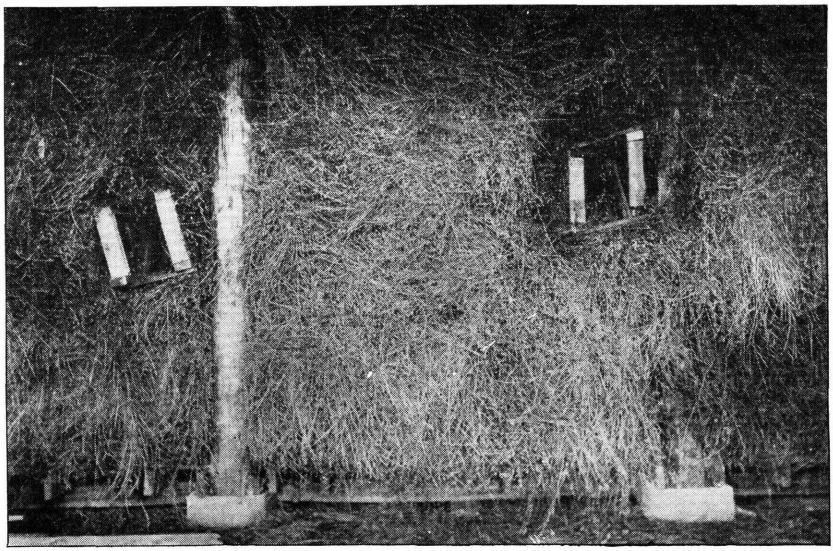

FIGURE 6.—Ventilators placed across the mow, at intervals of 7 or 8 feet, tend to check excessive heating.

across the mow at intervals of 7 or 8 feet. Where the mow is wide they are built in sections for convenience in handling. Figure 6 shows two of these ventilators in place.

Wherever alfalfa hay is stored in barns or sheds another method of reducing the danger of heating is to store the hay in bents 12 to 16 feet wide rather than in bents 20 to 25 feet wide. It is the common experience among farmers in the eastern part of the United States that less danger occurs from heating and spoilage in the narrow bents, because air circulation prevents the development of excessive heat. In many cases farmers place poles in the mows, particularly at the point where hay is dropped by the fork, to break the fall of the hay and to prevent greater density at that point than in other parts of the mow.

In some areas it is also a common practice to store the hay in chopped form rather than as long hay. The hay is run through a chopper at the time it is brought from the field and blown directly into the mow or other storage space. The chopped hay should be distributed evenly over the mow and should not be tramped, since this increases the danger of heating. Approximately two to two and one-half times as much chopped hay can be stored in the same space

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as long hay. Barns that have been designed to hold long hay should be well braced if hay is to be stored in the chopped form. In some of the Western States it is a common practice to chop the hay in the fall, preparatory for winter feeding. Chopped hay blown into a conical-shaped stack will shed moisture more easily than long hay, as external moisture seldom if ever penetrates more than 2 or 3 inches into the chopped hay. Feeders have found that the chopped hay can be removed from the mow or stack with less labor than long hay.

BALING ALFALFA

Of the alfalfa that is baled, by far the greater part is baled from the stack or mow after the hay has gone through the sweat. Alfalfa should not be baled from stack or mow during cold, windy weather, because much leaf shattering occurs under such conditions. The quality of alfalfa hay is often materially reduced by baling during unfavorable weather conditions. In the arid and semiarid districts considerable baling is done from the windrow or cock, by means of portable presses or pick-up windrow balers. In certain areas of the Southwest it is a common practice to bale the alfalfa hay at night, because thoroughly cured hay will become slightly tough during the night, thus preventing leaf shattering during the baling operation. Windrow baling has been practiced to a certain extent in the more humid sections, but unless the hay is baled very loosely and properly piled in storage, serious loss is likely to occur because of sweating or heating.

BROWN HAY

Occasionally farmers attempt to produce brown hay by stacking the hay before it is properly cured. The resultant discoloration varies, depending on the moisture in the hay at time of stacking and the compactness and size of the stack. Properly cured hay sweats in the stack or mow, but the sweat is not severe enough to reduce the green color or cause any appreciable loss in weight because of destruction of the dry matter. Hay containing only a small amount of excess moisture sweats more severely, and, as a result, loses some of its color. Such hay usually has a gray-green to a greenish-brown color, and the loss in dry matter is relatively small. Hay that is stacked when well wilted has a large quantity of excess moisture and heats in the stack, causing a distinct change in character. Such hay changes in color to a distinct brown and may in extreme cases become black or even charred. If the hay is compact so that air is excluded the heat kills the mold organisms, and so-called tobacco brown hay free from molds is produced. If air is not excluded the hay molds. In most cases some mold occurs on the outside of the stacks where the temperatures have not been high enough to kill the mold spores. Brown hay that is not moldy has a pleasant odor and is relished by livestock, although such hay has lost considerable weight because of the excessive heating. Most of the brown hay is the result of accident rather than of definite intention, because the various factors in its production are not well understood and cannot be controlled.

The advantages claimed for brown hay are greater feeding value and the reduction of loss as a result of unfavorable weather for curing. As to the former, opinion differs. Some farmers report excellent results from feeding brown hay; others have less satisfactory or

adverse results. Good brown hay is very palatable to stock. However, it has been determined that approximately 40 percent of the organic matter is destroyed in making brown hay.

Moreover, the conditions necessary for making brown hay result in the total loss of carotene, one source of vitamin A, and furthermore, evidence of actual loss of dry matter is shown even though the best methods are used. The experiments conducted by the Kansas Agricultural Experiment Station show this clearly and also that the loss is apparently increased with the length of time the hay is left in the stack and the degree of fermentation or organic change it undergoes. The feeding tests with beef steers made by the Kansas station, in which brown and black alfalfa hay were compared with bright field-cured hay, indicate that good brown hay is nearly as valuable for fattening as good green hay, and that either is much superior to black hay.

The Wyoming Agricultural Experiment Station states that in actual tests many farmers have satisfied themselves that brown hay is more palatable than bright or green field-cured hay and superior to it in feeding value for cattle and sheep. However, it is regarded by that station as being too dusty for horses.

From the reports at hand it is fairly conclusive that good brown alfalfa hay is equal or somewhat superior in palatability to good field-cured hay, but not superior to it in feeding value, and it is almost completely devoid of carotene.

Granting that the process by which brown hay is made does not make the hay more valuable, nevertheless the method involved would be important if it could be depended on for saving hay in humid climates, where satisfactory field curing is difficult. Such a method would enable the farmer to make good hay from his crop even if it contained a relatively high percentage of moisture.

Available experiments indicate that if external moisture is present on alfalfa—that is, if it is wet with rain or heavy dew—it cannot be made into a good quality of brown hay. Positive evidence, however, in support of this contention is lacking. Because of the danger from spontaneous combustion, farmers are advised not to attempt to make brown hay in their barns or mows. If they wish to make it, they should use good-sized stacks, since it is difficult to bring about proper conditions for making brown hay in small stacks.

ALFALFA-HAY STANDARDS

Commercial grades for alfalfa hay have been in use for many years and serve to facilitate its sale and purchase. The early grades established by the hay trade were indefinite and were not applied uniformly throughout the country. In 1925 the United States Department of Agriculture established standards that were based on extensive studies of the quality of alfalfa as it was produced in the various sections of the country. These standards are based on the principle of dividing the grade designation into two parts, grade and class. The grade refers only to the quality of the hay, whereas the class refers to the kind or mixture of various kinds of hay plants.

In the alfalfa-hay standards three factors are used to determine grade. They are leafiness, green color, and foreign material. Leafiness is considered to be the most important factor, because it in a

large measure reflects the protein content of the hay. The percentage of green color reflects the condition under which the hay was produced, and in a general way indicates the carotene or vitamin A content. Foreign material is a minor grading factor and becomes important only when alfalfa contains weeds or other foreign material in excess of the quantities permitted for the several grades. Certain special grades are also used to describe the superior or inferior qualities of the different types of hay.

Because alfalfa is grown over much of the United States, mixtures with other hays such as grass and timothy are rather common. These mixtures of alfalfa with other hay crops are cared for in the standards by classes in which the class name describes the kind of mixture. Thus the class name "Alfalfa" describes a type of hay that is practically pure alfalfa, whereas the class name "Alfalfa Light Grass Mixed" describes a mixture in which alfalfa is predominant, but which also contains an appreciable percentage (5 to 20 percent) of grass. In the same way the class name "Alfalfa Heavy Grass Mixed" describes a kind of hay with a large amount (21 to 60 percent) of grass.

Those who purchase alfalfa hay have found certain specific grades satisfactory for certain types of livestock—U. S. No. 1 or U. S. No. 2 Leafy Alfalfa for dairy cattle; U. S. No. 2 Alfalfa for horses; U. S. No. 1, U. S. No. 2 Leafy, or U. S. No. 3 Leafy Alfalfa or Alfalfa Light Grass Mixed for sheep; and low-grade hay, such as U. S. No. 3 and U. S. No. 3 Green Alfalfa, for stocker and feeder cattle. Small quantities of very high quality alfalfa hay such as U. S. No. 1 Extra Leafy Extra Green and U. S. No. 1 Extra Leafy Alfalfa are bought by the rabbit trade.

FEEDING ALFALFA HAY

Well-cured alfalfa is readily eaten by all classes of farm animals. In feeding value it excels hay made from any of the grasses, and though chemical analyses do not show it to be any higher in the important constituents than certain other of the legumes, such as cowpeas, soybeans, and clover, the fact that alfalfa is generally more palatable gives it a somewhat higher value for feeding. Good alfalfa hay included in a ration reduces the feed bill by doing away to a considerable extent with the necessity of purchasing protein feeds in the form of high-priced concentrates. The composition of green alfalfa, alfalfa hay, and various types of ground alfalfa are given in table 1.

TABLE 1.—*Composition of green alfalfa, alfalfa hay, and various types of ground alfalfa*

Item	Moisture	Ash	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Calcium	Phosphorus
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Alfalfa (green, immature)	79.4	2.9	5.2	0.7	3.8	8.0	0.28	0.09
Alfalfa (green, in bloom)	77.2	1.8	3.2	.6	7.8	9.4	.39	.07
Alfalfa hay	7.2	8.0	15.4	1.6	30.3	37.5	1.51	.21
Alfalfa leaf meal	8.5	14.4	20.9	2.6	15.7	37.9	1.42	.25
Alfalfa meal	8.2	10.0	15.2	2.2	27.5	36.9	1.56	.22
Alfalfa stem meal	9.1	7.7	11.4	1.3	36.1	34.4	------	------

Practically all farm animals show a preference for alfalfa hay cut in the early stages of growth, but this does not mean that such hay is always the best for feeding. On the contrary, certain animals, horses and mules in particular, do much better on hay made when the alfalfa is in full bloom, as the hay made at the early stages may be somewhat too laxative. Hogs cannot handle such coarse material, and unless the alfalfa is cut while still young and tender considerable wastage in feeding will result.

ALFALFA HAY FOR BEEF CATTLE

Good quality alfalfa hay is considered by most beef-cattle producers to be one of the best dry roughages for practically all classes of beef cattle. Usually, where alfalfa hay is available on the farm, it can well supply most if not all the necessary protein. It is seldom advisable to market the hay as such and purchase a protein-rich feed. Such a practice is to be recommended only when a material saving would result in the cost of protein for a given unit. When beef cattle are fed heavily on alfalfa hay alone, some difficulty may be experienced with bloating, but usually there is little trouble if they are fed small quantities of such roughages as corn stover or oat straw in conjunction with the alfalfa.

Breeding cows and yearling heifers can be wintered very satisfactorily on good-quality alfalfa hay alone. The same will hold true with feeder and stocker cattle. Experiments over a 3-year period at the United States Range Livestock Experiment Station at Miles City, Mont., showed that an average ration of about 23 pounds of alfalfa hay per day was sufficient for wintering a yearling heifer. Further experiments by the Bureaus of Plant and Animal Industry, United States Department of Agriculture, over a number of years at the Ardmore Field Station, Ardmore, S. Dak., showed that yearling steers wintered on 8 pounds of alfalfa hay and 4 pounds of oat straw per head per day made satisfactory winter gains, which were slightly greater than those made by steers fed 16 pounds of silage and 4 pounds of oat straw.

In cooperative experiments carried on by the Bureau of Animal Industry, and the Montana Agricultural Experiment Station, calves wintered on about 13.5 pounds per day of alfalfa hay alone made satisfactory winter gains, and although these gains were somewhat under those made by calves fed 12 pounds of alfalfa hay and 0.7 pound of cottonseed cake, and 9.4 pounds of alfalfa and 9 pounds of corn silage, respectively, the calves fed alfalfa hay alone made the greatest subsequent summer gains, and their production cost was materially lower. The addition of cottonseed cake to an alfalfa-hay ration or the replacement of 3.6 pounds of alfalfa hay with 9 pounds of corn silage in the average ration did not increase the yearly gains sufficiently to offset the higher costs.

In comparing the value of certain roughages for wintering calves the North Platte (Nebr.) substation found that alfalfa hay gave much larger gains than prairie or sorghum hay. Half-and-half alfalfa and prairie hay or alfalfa and sorghum hay gave approximately the same gain as alfalfa alone but much greater gains than either of the other roughages alone. In wintering yearling steers the results were quite similar; therefore, it is concluded that some of the cheaper roughages can be used economically with alfalfa.

In an experiment conducted by the Nebraska Agricultural Experiment Station comparing various combinations of corn, alfalfa, corn silage, and cottonseed meal, the corn and alfalfa gave the best results. In another experiment conducted by the same station, comparing 11 rations for feeding beef calves, the one composed of alfalfa hay, corn silage, and corn gave the best and cheapest gains and the most profit. In these experiments it was shown that alfalfa hay as a source of protein was cheaper than cottonseed meal. In a further comparison of rations a combination of alfalfa and silage gave the largest and most profitable gains.

It is the consensus of opinion among cattle feeders that if beef cattle have an abundance of alfalfa hay and corn it is not necessary to resort to other or additional feeds for fattening. It would be advisable to replace a part of the alfalfa hay with a protein concentrate in a steer-fattening ration only when protein can be supplied more cheaply pound for pound. It should be remembered in this connection that a certain amount of bulk in the form of dry roughage is necessary in a steer-fattening ration, and usually where alfalfa hay is available it will be advisable to depend on it for supplying this bulk as well as the protein required.

ALFALFA HAY FOR DAIRY COWS

Dairy cows require high-protein feeds to produce profitable flows of milk. These can be supplied by feeding nonleguminous roughage and various protein concentrates, but the latter are expensive and can be replaced to a considerable extent by various legumes. Alfalfa hay is especially suitable for this purpose, and, in addition, contains certain minerals in considerable quantity, especially calcium. It is also an excellent source of vitamins. In palatability it ranks high and has a laxative effect. The quantity of alfalfa hay that a cow will eat varies, but it is commonly estimated that a dry cow will eat 20 to 25 pounds a day and a milking cow 25 to 30 pounds.

The Kansas Agricultural Experiment Station found that butterfat could be produced somewhat more cheaply where alfalfa hay was included in the feed than where the rations were balanced with concentrates. In a comparative feeding test the Illinois station found alfalfa hay a little superior to wheat bran, while the Pennsylvania and Tennessee stations found it somewhat inferior. The Nebraska station concluded as the result of experiments that good chopped alfalfa hay was equal to wheat bran.

In California it is a common practice to feed cows almost entirely on alfalfa, either pasture or hay. Though an experiment conducted at the California station did not show any increased profit by the addition of barley to the ration, it is believed that, in general, the practice is economical and has a favorable influence on the condition of the cows and calves.

The Ontario Agricultural College and Experimental Farm found that with alfalfa hay and silage a cow can maintain her milk flow on a very small corn-meal ration and that where cows are far advanced in lactation the meal ration may be omitted entirely without decreasing the milk flow.

Experiments conducted by the Michigan station have shown that alfalfa can be used successfully in the ration as the principal source of

protein. In comparing ground and unground alfalfa at this station it was concluded that the difference in favor of the former was not sufficient to pay for grinding.

Tests conducted by the Pennsylvania station indicated that clover is somewhat inferior to alfalfa hay for milk production.

In trials conducted by the North Carolina station, alfalfa hay proved to be a little more efficient than lespedeza hay for milk and butterfat production.

The Arizona station in comparing hay cut in the bud stage with hay cut in one-third bloom for milk production found that there was less waste in feeding the former. Also the cows gave a little more milk and butterfat when fed bud-stage hay, which may have been due to the greater amount of bud-stage hay actually consumed.

Tests conducted by the Bureau of Dairy Industry showed that a straight alfalfa ration may be fed profitably when the hay is of good quality and that cows can be expected to produce about 65 percent as much as if fed a moderate amount of grain in addition to the hay.

The Oregon station, on the other hand, reports that alfalfa hay as a sole ration is not profitable. Feeding chopped hay increased production, but not to a profitable level.

The Washington station concluded that it is economical where feed must be purchased to feed as much alfalfa hay as dairy cows will consume and to feed concentrates to provide nutrients for production greater than that provided for by the alfalfa hay.

In tests conducted by the Indiana and Wisconsin stations alfalfa hay proved somewhat superior to soybean hay for milk production. The Arkansas station concluded that leafy bright-colored soybean hay cut before the stems become mature is equal to alfalfa hay for growing heifers.

In general, when alfalfa replaces to a large extent the high-priced concentrates, the profits derived from milk and butter are increased. In all cases alfalfa has shown its superiority to grass hays. It is equal, if not superior, to hay made from any other legume, and the best alfalfa hay is only slightly inferior to wheat bran from a protein and net-energy standpoint. Alfalfa ordinarily is a good source of carotene, whereas bran is deficient in carotene and lower in fiber and higher in phosphorus than alfalfa.

ALFALFA HAY FOR HORSES AND MULES

Horses and mules are fond of alfalfa and, when it is fed with discretion, thrive on it exceedingly well. Instances are on record where work has been performed on alfalfa hay alone, but such a practice is not only wasteful but likely to result injuriously to the animals. To get the full benefit from the protein in the alfalfa, at least a small grain ration should be fed.

In comparative tests of alfalfa, Johnson grass, Bermuda grass, timothy, and lespedeza for mules, the Mississippi Agricultural Experiment Station found that alfalfa stood first in feeding value and cheapness of gains. As a result of experiment the Kansas station found that corn and alfalfa when properly fed gave the cheapest ration for work horses in that State. Alfalfa hay proved to be more valuable as roughage than prairie or timothy hay and, when fed with corn and

oats, reduced the cost of the daily ration 25 to 35 percent. The Illinois station reports that less grain was required with alfalfa than with timothy to prevent farm horses from losing weight. Studies conducted by the Michigan station showed that horses fed corn and first-cutting alfalfa maintained their weight and health and efficiently did just as much work of various kinds as their teammates eating corn, oats, and timothy, and at a lower cost. At the Utah station it was shown that horses could be maintained at less expense and in better condition on alfalfa than on timothy.

These experiments and others show conclusively that alfalfa is one of the best roughages for horses, despite the prejudices of some farmers. Numerous cases are on record where for years alfalfa hay has supplied most of the roughage portion of the ration for work horses without injurious effect. In most cases harmful results can be traced to overfeeding or to spoiled hay. To feed most economically horses that are at work should have approximately 1 pound of hay a day per 100 pounds of live weight. The first cutting, being considerably coarser, is better for horses than the subsequent cuttings, which are likely to be washy.

Authentic instances are reported in which horses and mules have eaten the stems and left the leaves of good alfalfa hay, but a satisfactory explanation for this has never been offered.

ALFALFA HAY FOR SHEEP

Alfalfa hay is an excellent feed for sheep, either for breeding stock or for fattening. It is also used extensively for wintering sheep in the West, where not less than 4 or 5 pounds is allowed per ewe per day when hay alone is fed. Ordinarily coarse and stemmy hay is not so good for sheep as the fine-stemmed hay.

The New Mexico Agricultural Experiment Station was able to produce mutton of a quality suitable for local markets on alfalfa hay alone, but the addition of a little grain gave larger returns per acre of alfalfa hay, the cheapest gain being made on alfalfa hay and one-fourth of a pound of corn a day. More rapid gains, a shorter feeding period, and a better product resulted from the addition of grain. The Illinois station found that the most rapid gains were made when the proportion of corn was as great as the lambs would consume. With cheap corn such a ration gave the cheapest gains, but it is concluded that in feeding for profit the feeder must be guided to some extent by the relative prices of corn and alfalfa hay in determining the proper proportion of each. The Kansas station has been able to carry breeding ewes through the winter almost exclusively on alfalfa hay.

The Kansas station also found that sheep fed alfalfa hay made greater gains and required less grain than did the lots on timothy and prairie hay. Alfalfa hay proved a little more advantageous than clover hay. Lambs made more rapid gains and at less expense on alfalfa hay than on cowpea hay. The New York (Cornell) station found that chopping the hay did not increase the gains of ewes sufficiently to warrant the expense.

In general, it is concluded that though sheep may be kept in very good condition on alfalfa alone, the addition of a little grain is advisable both for breeding animals and for those being fattened.

ALFALFA HAY FOR HOGS

Hogs, because of the limited capacity of their digestive tracts, cannot economically digest dry hay or fodder, but an exception to this appears in the case of green leafy alfalfa which is more valuable as a source of vitamins, protein, and calcium than as a source of energy in the hog ration. Some hogs may not eat alfalfa hay readily at first but, after becoming accustomed to it, relish a limited quantity, especially if it is made from plants cut at an early stage of maturity. As has previously been pointed out, however, there is danger of injuring the stand seriously by harvesting the alfalfa before it is well in bloom. To maintain a stand as long as possible, it is necessary to sacrifice the palatability to some extent by delaying the cutting until a later stage.

Several State agricultural experiment stations have conducted experiments in feeding alfalfa hay to hogs. Practically all of them report very satisfactory results. In almost every case the addition of alfalfa hay to a grain ration reduced the cost of gains and improved the physical condition of the hogs. The North Dakota station found that when brood sows were fed alfalfa hay the grain ration could be reduced from one-third to one-fourth. When a one-fifth to one-sixth ration of alfalfa hay was fed with grain, considerable saving was effected in fattening hogs. At the Nebraska station brood sows were wintered on good alfalfa hay alone, but the results were more satisfactory where the animals also received 1 pound of corn for every 100 pounds of live weight. As a result of another experiment at this station, alfalfa as a source of protein gave cheaper gains than tankage. Of several fattening rations for hogs, none was equal to corn and alfalfa when fed in the ratio of 9 to 1. At the Kansas station it was found that the gain on corn meal alone was more costly than where the hogs received alfalfa hay in addition to corn.

In several instances steamed hay has been compared with dry hay, and the general conclusion is that although the former gives somewhat larger gains, the gains are not sufficient to justify the additional expense of steaming. Practically the same conclusions have been reached in comparing ground and chopped alfalfa hay with unchopped hay.

Alfalfa is an ideal feed for brood sows, and in general less trouble occurs with swine diseases when liberal quantities are fed.

ALFALFA PRODUCTS FOR POULTRY

Alfalfa is often included in laying and growing rations for poultry as a source of carotene and riboflavin (vitamin G). The two products most commonly used are alfalfa meal and alfalfa-leaf meal, which are usually mixed with other ingredients and fed as a mash. For this purpose alfalfa meal made from hay cut at an early stage of growth and well cured is preferred because of its higher vitamin content. Trials conducted by the Wisconsin Agricultural Experiment Station gave no evidence that as much as 10 percent of alfalfa in the ration was detrimental to egg production or to the general well-being of the pullets. It is concluded that a farmer who raises the needed grain for a poultry ration but purchases alfalfa-leaf meal

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will probably find it most economical to use not more than 5 percent alfalfa in the mash, whereas one who grinds his own hay for feeding poultry may want to use 10 percent. The South Dakota station found that good alfalfa meal replaced wheat bran or middlings in the laying mash and gave even better egg production. It must be recognized, however, that the alfalfa meal might be furnishing certain essentials that are lacking in the bran or middlings. Therefore, these feeds are not necessarily interchangeable. In a trial conducted by the Ohio station somewhat better egg production was secured from the hens that received chopped alfalfa hay than from those that received alfalfa-leaf meal as part of the mash. The egg production from the two groups receiving 5 and 10 percent of alfalfa-leaf meal in the mash was practically the same. The hatchability of eggs from all three groups averaged nearly the same.

PASTURING ALFALFA

As far as palatability and carrying capacity are concerned, few plants excel alfalfa for pasturage. The crop should not be pastured the first year, however; though it may be pastured lightly the second, it is better to delay grazing until the third year, when the plants will have become more thoroughly established.

In the East, unless extreme caution is used to avoid overpasturing, grazing at an improper stage of growth, or grazing when the land is wet or frozen, there is danger of seriously injuring or destroying the stand. The danger does not seem to be so great west of the ninety-seventh meridian. Although close grazing may be harmful to alfalfa at any time, continued close grazing is especially harmful in the fall, as it does not give the plants an opportunity to store up a reserve of food in the roots to carry them through the winter and to start vigorous growth in the spring. The same precautions against injury should be observed as in cutting (p. 4); that is, the plants should be allowed to make a recovery growth of 10 or 12 inches to store up an abundance of food in the roots. This late growth should not be grazed until cold weather has set in, thus preventing subsequent growth and resultant depletion of root reserves. As they have a tendency to graze so closely as to injure the crowns of the plants, horses, mules, and sheep are more likely to injure alfalfa than are cattle and hogs.

When alfalfa is grazed regularly and closely, plants die, the stand thins out, and weeds come in. This condition can be obviated to a considerable extent by dividing the alfalfa field into a number of smaller fields and grazing the stock on each in succession. When the alfalfa is ready to cut for hay, enough stock is turned in to eat down the crop in about 2 weeks and is then transferred to another field. Sometimes a field becomes too nearly mature before it is reached in the regular rotation, and then it is necessary to cut the crop for hay. Under the system of alternate grazing and resting, good stands have been maintained much longer than when the fields were continuously pastured.

CATTLE ON ALFALFA PASTURE

All classes of cattle do exceptionally well when grazed on alfalfa, but there is always more or less danger of bloat. The danger is greatest in humid sections, but bloat may occur in any section, even

in the West, under irrigation where a dry climate prevails. Some farmers who have pastured cattle on alfalfa for years have met with no difficulty, whereas others under conditions apparently the same have sustained heavy losses. A satisfactory explanation for this has not yet been offered; in fact, the conditions that cause bloat are not well understood. Generally, the danger from bloat seems to be greatest when the alfalfa is young and tender.

Experience seems to point to other conditions that induce bloat, and as a result certain precautions are advised which it is thought will greatly reduce the risk. General recommendations are: (1) Do

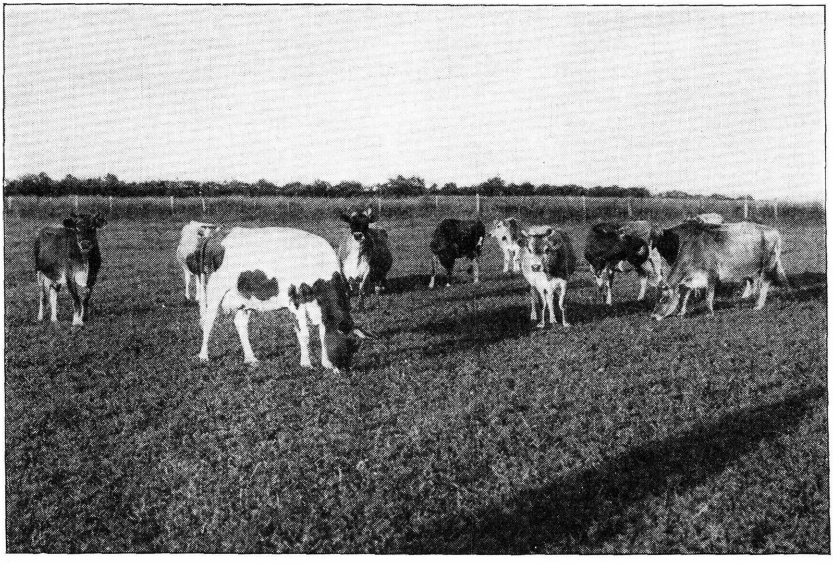

FIGURE 7.—Dairy cows grazing on alfalfa. Cattle should be rotated from one field to another, in order to give the alfalfa a chance to make normal top growth and to reduce the danger of injury to the stand.

not turn the cattle into the field when the alfalfa is wet with rain or dew; (2) let the animals feed on other forage, preferably hay, before turning them in on alfalfa; (3) allow the cattle to graze only a few minutes at a time until they have become accustomed to it, and then do not take them out of the field except for water; (4) sow some grass seed with the alfalfa, and have a patch of grass where the stock can graze on it at any time; (5) have in the field a stack of hay or straw, to which the cattle have free access; and (6) have water and salt easily accessible to them.

If bloating occurs, various remedies are available that are more or less efficacious when used in time. One commonly suggested is to drench the animal with a pint of raw linseed oil to which is added four tablespoonfuls of turpentine. This remedy may afford relief in the early stages, but when the case is well developed it is rarely that an animal can be saved except by the use of a trocar. Probably the most common treatment is to exercise the animal by compelling it to walk. If at the same time a piece of rope or hose or a bit of some kind is placed in the animal's mouth to induce chewing, the escape

of the gas through the mouth appears to be facilitated. Standing the animal with its front feet higher than its hind feet is also thought to be helpful. A veterinarian should be called when symptoms of bloat first appear, unless the person in charge has the experience and the equipment required to handle serious cases.

In experiments carried on by the Michigan Agricultural Experiment Station in cooperation with the Division of Forage Crops and Diseases of the Bureau of Plant Industry, alfalfa furnished excellent spring and summer pasturage for dairy cows with no bloating and no apparent injury to the alfalfa. Using one cutting for hay and another for pasture gave greater returns than did an attempt to get continuous grazing from alfalfa. On the basis of 1931 milk and hay prices, alfalfa proved more profitable as a pasture crop than as a hay crop. In other trials at this station a mixture of brome grass and alfalfa when grazed gave somewhat larger returns than alfalfa alone. Very satisfactory results have been obtained by the Division of Forage Crops and Diseases in pasturing beef cattle on alfalfa at West Point, Miss.

Because of the danger of bloat, very few experiments have been conducted to determine the number of cattle a given area of alfalfa will carry, but it is generally estimated that 1 acre will support steadily 2 animals of approximately 900 pounds each for 2 months. The gains made by all classes of cattle on alfalfa pasturage, except where cases of bloat occur, are almost without exception highly satisfactory (fig. 7).

HORSES ON ALFALFA PASTURE

Alfalfa makes a very good pasture for horses and mules. Work stock keep in good flesh when fed a small quantity of grain daily in addition to alfalfa pasturage. It is especially good for mares and their foals. The Kansas Agricultural Experiment Station found that to get the greatest growth and development in horses it is necessary to feed some grain with alfalfa pasturage until the animals reach maturity.

In numerous cases alfalfa pasture has formed the major portion of the ration for working animals for a considerable time with no injurious results, and instances have been reported where horses have performed heavy work during the summer on nothing but alfalfa pasture. However, such feeding is not recommended for draft or driving horses.

SHEEP ON ALFALFA PASTURE

Sheep are fond of alfalfa pasture and thrive on it if they do not bloat. In the irrigated valleys of Arizona and California and some other sections of the West sheep are grazed regularly on alfalfa during the winters, but very few experimental data are available as to the carrying capacity per acre, the losses that may be expected, or the gains that can be depended upon.

The Colorado Agricultural Experiment Station, after collecting data from many large sheepmen, reached the conclusion that where the precautions that are recommended in pasturing cattle on alfalfa are followed, the loss of sheep can be kept down to 5 percent, but where these precautions are not followed the losses usually run very high. This station recommended that only old ewes and their lambs be kept on alfalfa pasture, as they are less subject to bloat than young ewes

or wethers. The carrying capacity of an acre was given as eight ewes and their lambs, from the middle of April to the first of October.

As a result of investigations conducted at the Belle Fourche (S. Dak.) field station it was concluded that in pasturing sheep on alfalfa losses from bloat might occur, but farmers having large numbers of sheep usually have not considered such losses heavier than those that occur on the range from other causes.

HOGS ON ALFALFA PASTURE

In general, better results are obtained by pasturing alfalfa with hogs than with any other livestock. Hogs thrive on it and with

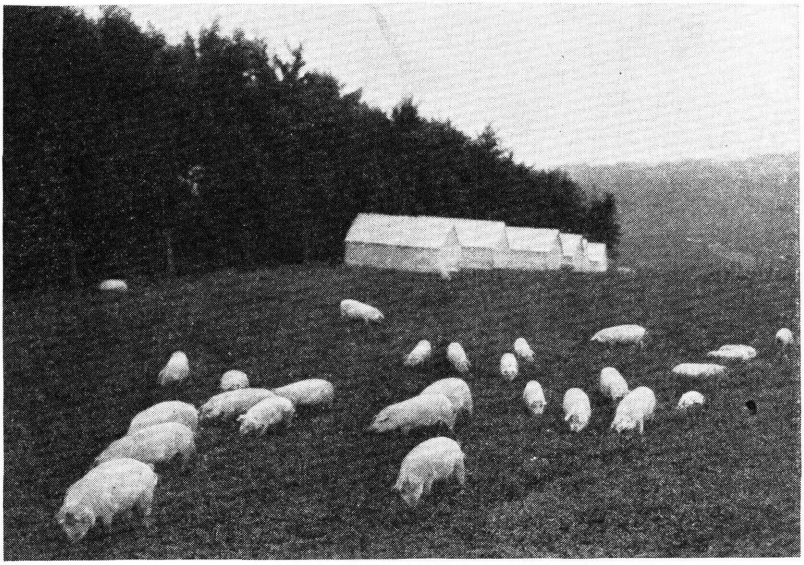

FIGURE 8.—Hogs thrive on alfalfa pasture and with proper precautions cause little injury to the stand.

proper precautions cause little injury to the stand. They do not trample the soil as much as heavier animals and therefore, even in wet weather, do little damage. Everything considered, the results will be more satisfactory if the field is divided into two or more lots, so that the danger from overgrazing any portion of it may be reduced to the minimum. A practice commonly recommended as safe to follow, even in the Eastern States, is to limit the number of hogs per acre, so that one or two cuttings of hay, depending on the section, may be secured during the season. Unless the fields are grazed down closely, hogs usually will not do much rooting, but should they be inclined to root they may be prevented from doing so by putting rings in their noses.

Although hogs will make some gain, alfalfa pasturage alone is barely more than a maintenance ration. To get them in condition for market it is therefore necessary to feed a small quantity of grain. With this combination hogs can be made ready for market cheaper than by means of any other feed. In a large number of experiments, a grain ration of 2 pounds for every 100 pounds of live weight has been found

the most economical, but with a larger grain ration the gains are more rapid and the returns per acre somewhat higher. Generally speaking, the sooner a hog can be put in shape for the market the more profitable will be the returns, the smaller the chances of loss from cholera and other causes, and the smaller the interest on the investment. Furthermore, if the hogs are in good shape from the time they reach a weight of 200 pounds, the farmer is in a position to take advantage of the market conditions; that is, the hogs are always marketable and can be shipped when the price appears to be most satisfactory.

The carrying capacity of an acre of alfalfa depends on the condition of the stand and varies with the locality. In the East, where the stand is more easily injured by overgrazing, it is not advisable to attempt to carry as many hogs to the acre as in the irrigated sections of the West. If grain is fed in connection with the pasture, an acre will, of course, support more hogs than if no grain is fed. Ordinarily an acre of good alfalfa in any part of the country should carry 8 to 10 hogs weighing 100 pounds each with little danger of injury to the stand. Under the most favorable conditions an acre has been known to support twice this number, but such heavy grazing is very likely to prove harmful and cannot be recommended except in cases where the field is soon to be plowed. Where alfalfa can be grown successfully, good returns may be expected from hogs pastured on it if a small-grain ration is fed at the same time (fig. 8).

POULTRY ON ALFALFA PASTURE

All kinds of poultry relish green alfalfa, and giving hens access to a field has a very good effect in maintaining egg production. It is best to have the field divided, so that the fowls may be changed occasionally; otherwise the constant nipping back of the shoots is detrimental to the plants. Even under the best system of management, chickens have a tendency to keep the alfalfa eaten so closely on the portion of the field nearest their houses or coops that the plants are soon killed.

The yolks of eggs from birds on alfalfa pasture are likely to be extremely dark and, when placed in storage, become dark enough to be objectionable.

ALFALFA AS A SILAGE CROP

Alfalfa is used for silage to a limited extent. It does not lend itself so well to silage making as corn, and in many sections is outranked by corn, small grains, and other forage crops in the green weight produced at a single cutting. Silage that has been made from alfalfa has not been uniformly satisfactory; more information with reference to handling it is necessary. Some of the silage has been of excellent quality, and some has been unfit for use; that is, it has developed a very foul odor and has become moldy and slimy. This same difficulty has occurred in attempts to ensile many of the other legumes. Because of the high percentages of protein and basic minerals in alfalfa and the low content of soluble carbohydrates, special precautions must be taken to insure that a lactic acid fermentation rather than putrefaction occurs.

Notwithstanding the unsatisfactory features in connection with the use of alfalfa as a silage crop, it is being used to an increasing extent

for this purpose. When weather conditions are not favorable for the curing of hay, alfalfa may be put into the silo. Good silage can be made from partly wilted alfalfa, provided it is cut fine and is well packed into the silo. Where alfalfa is partly cured before ensiling some external moisture may improve the silage, but experience indicates that a washy silage is likely to result where freshly cut alfalfa is put up while wet with rain. Furthermore, wet fields and bad weather interfere with the operations of silage making as well as with haymaking. Since the filling of a silo is usually done cooperatively by the farmer and his neighbors, it is not always possible or economical to handle partly cured hay in this manner. The filling of a silo is not as simple an operation as stacking hay or putting it in barns.

Alfalfa and corn mixed make good silage. The relatively high percentage of carbohydrates (sugar and starch) in the corn is conducive to the right kind of fermentation. For this reason mixing alfalfa with the sorghums or small grains is advantageous. Preliminary experiments carried on by the Department of Agriculture indicate that good silage can be made by mixing alfalfa and the straw of any of the small grains, provided the mixture is made when the material passes through the silage cutter and water is added, if necessary, to make it pack properly. Molasses has been used to a slight extent in making alfalfa silage for a number of years, but its use has increased enormously during the last few years. Although molasses increases the acidity slightly, thus tending to check undesirable fermentation, its main advantages are that it improves the odor and increases the palatability of the silage. The quantities generally recommended are 60 to 80 pounds of molasses to a ton of green alfalfa.

A method of making silage called the A. I. V. process is based on the use of acids in quantity sufficient to reduce the acidity to below pH 4, thus preventing undesirable fermentation. Hydrochloric and sulfuric acids are the ones most commonly used in making this type of silage. The acids diluted with five volumes of water are pumped into the silo and sprinkled over the chopped alfalfa. The amount of dilute acid usually required to increase the acidity to a point below pH 4 is 5 to 8 percent of the green weight.

Acids are destructive to masonry or concrete, are troublesome to apply, must be neutralized in feeding, add no nutritive value, and impair palatability. Acids were formerly thought to preserve carotene, but recent investigations of the Bureau of Dairy Industry have shown that much of the material that has passed as carotene, by the usual methods of determining, is not true carotene. In feeding silages to which acid has been applied, finely ground limestone at the rate of 1 ounce per 10 pounds should be sprinkled over the silage to neutralize the acid. Liquid phosphoric acid has been used to a limited extent in making alfalfa silage. The quantity advised is 0.8 percent of the green weight or 16 pounds (1¼ gallons) to a ton. Advantages claimed for phosphoric acid are that it reduces the acidity of the silage, insures against phosphorus deficiency, and returns any phosphorus not used by the animals to the soil in manure.

Because alfalfa is not regarded as an ideal silage crop, where conditions are favorable, it is usually advisable to cure it for hay rather than to put it into the silo. However, it will make good silage, when properly cut and packed, especially if mixed with corn or sorghums or the small grains, and the feeding value of alfalfa silage is very high.

With a knowledge of these facts the farmer should be able to judge for himself whether it will be to his advantage to put his alfalfa crop into the silo.

ALFALFA AS A SOILING CROP

Alfalfa is sometimes cut and fed green, but notwithstanding the fact that this method of handling the crop has proved highly satisfactory the practice is confined largely to the dairy farms of the northeastern quarter of the United States. The Arizona Agricultural Experiment Station estimates that by utilizing alfalfa as a soiling crop 35 acres will carry 100 steers weighing 900 pounds each through the growing season, which is about double the returns that could be expected from pasturage. In Canada it is claimed that the cost of producing pork is reduced 25 to 50 percent when green alfalfa is fed with grain, as compared with grain alone.

The main objection to feeding alfalfa green is the extra amount of labor involved, although this is doubtless more than offset by the increased production per acre and the better condition in which the stands are maintained as compared with pasturing. The only precaution necessary is to cut the crop no earlier and no oftener than it would be cut for hay. No cases are recorded of alfalfa causing bloat when used as a soiling crop.

ALFALFA TEA

From time to time articles have appeared in newspapers very highly recommending alfalfa tea as a feed for pigs and calves. The tea is made by pouring boiling water on the hay and allowing it to steep for a few hours or by stirring alfalfa meal into cool water and straining the mixture after it has stood several hours. In feeding, some grain is added to the tea. Several State experiment stations have conducted tests to determine the value of alfalfa tea.

The Wyoming station found that growing pigs receiving a grain ration consisting of one-half corn meal and one-half middlings mixed with alfalfa tea made better gains than where water replaced the tea, but the gains were hardly sufficient to justify the additional expense. In feeding alfalfa tea to calves the Kansas station obtained poor gains, and it seemed almost impossible to keep calves from scouring. It appears, therefore, that about the only conclusion that can be drawn from the results of the actual experiments with alfalfa tea is that it does not give sufficiently good results to justify the extra labor involved in making and feeding it either to pigs or calves.

ALFALFA STRAW

In the production of alfalfa seed the forage feature of the crop is of secondary consideration. Attention is focused on the seed crop, and practices are followed that give the best returns in quantity and quality of seed. Therefore it frequently happens that the straw, as the stems and leaves are commonly called after the crop is threshed, is less valuable from a feeding standpoint than if an attempt were made to obtain the best forage possible without sacrificing the seed crop unduly. For example, when the crop is harvested as soon as most of the seed pods are mature and while the plants still retain

some of their green leaves, the straw is of higher feeding value than when the plants are left until the pods are entirely ripe and the leaves have fallen.

Where forage is of more concern, it is better to cut the crop while the stems and leaves are somewhat green, as the increased forage value of the straw more than offsets the loss due to immature seed. If the straw is from the first crop of the season, it is likely to be coarser and have fewer leaves than if it is from the second or subsequent crops. It is therefore regarded as being less palatable. In some sections farmers prefer straw from the first crop, as it is likely to contain a larger proportion of grass than the later cuttings and is thought to be of higher feeding value. Of course, in some sections the season is not long enough for more than one crop.

Opinions differ greatly with regard to alfalfa straw. Some farmers think it is better when the crop is grown under irrigation, as it contains more leaves and consequently is more valuable as a forage. There seems to be little in this contention. Some think if the crop is stacked as soon as it is harvested more leaves are retained and the curing that takes place in the stack improves the quality of the stems. Although this may be the case, there is no definite evidence in support of it.

Again, alfalfa straw is regarded by some as practically worthless for feed, but this is probably because their experience has been confined to a very poor grade of straw or straw that had become damaged by weather after threshing. Most farmers, however, who have had considerable experience in feeding alfalfa straw estimate its value at one-third to one-half the value of good alfalfa hay, and ordinarily this is the basis upon which it sells. Its actual value depends upon the time it is cut, the manner in which it is handled, and the conditions under which it is grown.

Most of the alfalfa straw that is produced is fed to cattle, and in some cases cattle are carried through the winter on it with no supplemental feed. This practice is not to be recommended, however, for the straw, even when it is of good quality and eaten in large quantities, is barely a maintenance ration. Calves and old cows have difficulty in chewing it properly. It is not considered very satisfactory for dairy cows. Work horses and mules do very well on alfalfa straw if a liberal supplemental grain ration is fed, but more grain is required than with alfalfa hay. Sheep seem to do better on alfalfa straw than any other kind of farm animals, provided their teeth are in good condition.

In threshing the alfalfa-seed crop, the stems and leaves are broken and pulverized more or less, depending on the type of threshing machine used and whether the material is passed through the machine one or more times. Unless care is taken in feeding it, considerable waste results. Feeding directly from the stack is most unsatisfactory and wasteful, as the animals soon eat all of the fine material and leave the coarse stems until the last, which usually means that these are not eaten at all. If the straw is hauled from the stack and fed upon the ground a loss also ensues, particularly of the fine material. The most satisfactory method is to feed the straw in tight-bottom mangers, giving only enough for one feed at a time (fig. 9). In this way the fine material is not lost, and very little of the coarse straw is wasted.

Some care and judgment are necessary in feeding alfalfa straw to get the best results and at the same time to avoid the loss of stock. The greatest source of danger in this connection is impaction. When

straw is fed alone the animals are forced to eat large quantities to get enough nutriment to meet their requirements. Under such conditions balls composed of dirt and fine particles of straw form in their stomachs, thereby blocking the passage between the stomach and intestines and very frequently causing death. This is not so likely to occur if the animals have access to salt and water at all times or if they have grain or pasture in addition. Cattle on pasture frequently seem to relish a little straw, but they will not eat large quantities of it unless compelled to.

After all, the chief value of the alfalfa straw is that it furnishes some roughage, and the best results are secured when it is fed with a grain

FIGURE 9.—Cattle being fed alfalfa straw in mangers to avoid waste. The feeding value of good alfalfa straw is estimated at one-third to one-half that of good alfalfa hay.

ration. Spoiled or moldly straw is very apt to result in derangement of the digestive tract, which sometimes proves fatal.

In times past alfalfa straw has been used very satisfactorily as a mulch in the citrus orchards of the Southwest. Its utilization for this purpose, however, is practicable only when the straw is cheap. Spoiled and low-grade hay are also used to some extent as a mulch in citrus orchards.

ALFALFA AS A GREEN-MANURE, SOIL-IMPROVER, AND ORCHARD COVER CROP

As a rule alfalfa is not a satisfactory green-manure crop. Like many other perennials, it is slow to start, does not produce tonnage quickly enough, and in many sections is expensive and difficult to establish. There are other crops available that are so much more satisfactory for this purpose that alfalfa cannot compete with them.

Where alfalfa has been grown on land for a series of years in regions of abundant rainfall or under irrigation it has a beneficial effect on succeeding crops, with the possible exception of certain legumes.

Under dry-farming conditions alfalfa frequently reduces the soil moisture to such an extent that the yields of subsequent crops are decreased.

In apple districts of the Rocky Mountains and the Northwest Pacific Coast States where irrigation is practiced, alfalfa as a permanent or semipermanent cover crop appears to be the best crop known for correcting certain soil troubles and the physiological diseases of fruit trees resulting therefrom. Because of its success in the West it is being tried to some extent in apple orchards in the humid Eastern States. Occasionally removing a crop of hay reduces the beneficial effects. The results are more satisfactory in the long run when the entire season's growth is left to maintain or increase the productivity of the soil. The arsenical sprays sometimes used on fruit trees make caution necessary when pasturing or feeding the hay upon which the sprays have fallen.

GROUND ALFALFA

The term "ground alfalfa" is used to describe all alfalfa that has been chopped or ground to a fineness that gives it the appearance of meal rather than chopped hay. Ground alfalfa is generally used as a concentrate rather than as a hay. In other words, ground alfalfa is either mixed with other ingredients and fed as a mixed feed or fed in small quantities to supplement the grain portion of the ration. It is not often used in large quantities to supply the forage requirements of the animal.

Considerable uncertainty seems to exist as to when and where the first alfalfa was ground into meal, but it is pretty well established that one of the first attempts, if not the first, to manufacture it on a commercial scale was made at Wichita, Kans., about 1904. This attempt, although not particularly successful, attracted attention to the possibilities of developing an industry, and during the next few years several mills sprang up in various parts of the country. Among the facts contributing to the rapid development of the industry were the increase in the popularity of mixed feeds, the extensive advertising campaign that was being conducted in the interest of alfalfa, and the desire to find a profitable outlet from the remote districts of the West.

Most of the early mills were built in Kansas and Nebraska, but many of these failed for one reason or another, and as new plants were established the industry moved westward, where the climatic conditions were more favorable and larger supplies of alfalfa were available.

Since 1930, however, another shift has been made in the location of the alfalfa-grinding plants to Ohio and Michigan. At present the following States are important in the production of alfalfa meal: Colorado, California, Nevada, New Mexico, Arizona, Michigan, Ohio, and Pennsylvania. Colorado probably leads in the number of mills and the output of ground alfalfa. The production of ground alfalfa is concentrated in a small number of companies who usually have small plants situated at a number of places located convenient to the supply of alfalfa.

For a number of years the Agricultural Marketing Service has been issuing alfalfa meal production reports which indicate that approximately 400,000 tons of meals of all kinds are produced each year.

This includes about 100,000 tons of artificially dried meal. To what extent the production of ground alfalfa can be increased without widening its use cannot be predicted. The fact that production has increased but slightly over a period of years would seem to indicate that the supply of meal is sufficient to meet the requirements of the mixed-feed manufacturers and other demands.

BUILDINGS

In constructing buildings for alfalfa mills the desirable features are to have them cheap, durable, and as nearly fireproof as practicable. In most cases they are frame structures covered with corrugated sheet iron (fig. 10). The main building which houses the machinery is

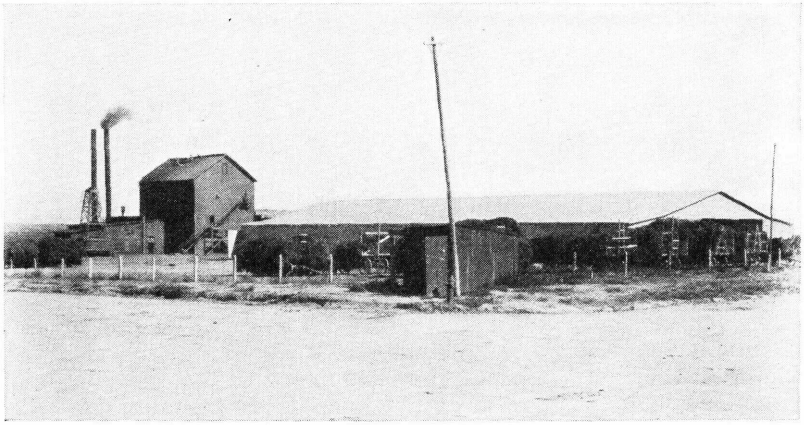

FIGURE 10.—A typical alfalfa-meal mill. Desirable characteristics in such buildings are cheapness, durability, and noninflammability.

frequently of noninflammable material, to reduce the fire risk. Attached directly to this main building, or, more commonly, separated by a distance of 30 feet or more, are warehouses; usually one for receiving hay, with an average capacity of 50 to 100 tons of loose hay, and at least one for storing the meal, with a capacity ranging from a few hundred to 4,000 or 5,000 tons. These structures are generally on opposite sides of the mill proper, although not uncommonly they are placed at right angles to each other, the arrangement depending largely on the ground that is available. Usually the floor in the hay warehouse is of concrete, and sometimes the floor in the warehouse for the meal is of the same material. There is, however, some objection to the use of a concrete floor in meal warehouses, as the moisture in the concrete rots the sacks and causes spoilage if the meal is left in contact with the floor for a considerable time. Men of experience, however, contend that the concrete becomes thoroughly dry after 2 or 3 years, and then the objection no longer holds. Spoilage from moist concrete may be obviated by covering the floor with planks, but this, of course, increases the cost and the fire risk. In addition to the buildings described above, there is nearly always a small building for the office and scales.

MACHINERY

The essential machinery in a well-equipped mill consists of an electric motor, a steam or internal-combustion engine, two grinders, screens, blowers, packers, cyclones, and other dust collectors, wagons, conveyors, and scales.

The power used in operating the mill depends largely on what is available. In sections where electricity may be had, most mills have two electric motors, one of 150 to 300 horsepower for running the grinders and another of 50 horsepower for running the fans and

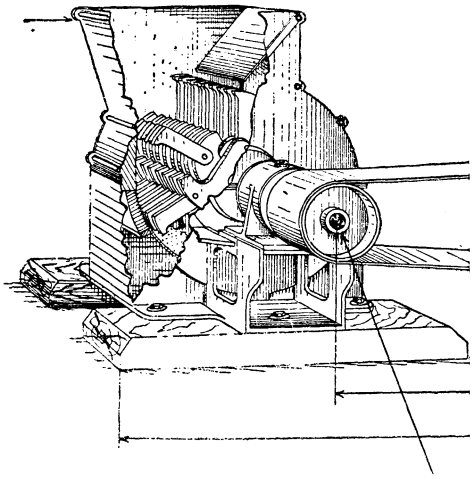

FIGURE 11.—The swinging-hammer mill is the type most commonly used for reducing alfalfa hay to meal.

packers. Where electric power is not available, steam or internal-combustion engines are used.

Grinders or pulverizers are of various advertised capacities up to 12 tons an hour, but this high capacity is possible only under the most favorable conditions. In actual practice it is seldom safe to count on more than half the advertised capacity. The moisture content of the hay is very largely the determining factor. Strength is one of the prime requisites for a grinder, as the machinery is subject to a great strain, particularly when the alfalfa is tough.

Alfalfa hay is reduced to meal by one of two methods—one reduces it to small particles by breaking or grinding and the other by cutting. The advantages claimed for the cutting machines are that the hay may be handled with more moisture and that the resulting meal is practically free from the dust that is objectionable from a feeding standpoint. Most of the mills now in use, however, depend on the grinding or pulverizing principle. The grinder in most general use consists of a large number of swinging steel hammers, which are fastened to plates of steel with three or four arms, each arm bearing a swinging hammer. The steel plates are fastened firmly to a revolving shaft (fig. 11). Other types of grinders have been used to a limited extent.

One of the machines that reduces the hay to meal by cutting works on practically the same principle as the ordinary silage cutter, but has a special attachment for reducing the meal to a finer consistency.

All hammer mills are equipped with perforated steel plates through which the meal passes when it becomes sufficiently fine. The size of these perforations determines the fineness of the product (fig. 12).

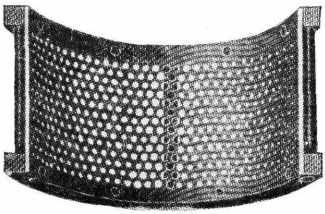

FIGURE 12.—Perforated steel plates used in hammer mills. The size of the perforations determines the fineness of the alfalfa meal.

Hammer mills are generally equipped with large metal fans to reduce the back pressure from the hammers and to convey the meal from the grinders to the cyclones (fig. 13).

The cylones (fig. 14) are hollow cones made of galvanized sheet iron, the top projecting through the roof, while the bottom or discharge end is over the packers.

Practically all mills are equipped with dust collectors, which catch the finest particles of meal that are seen escaping as a green dust

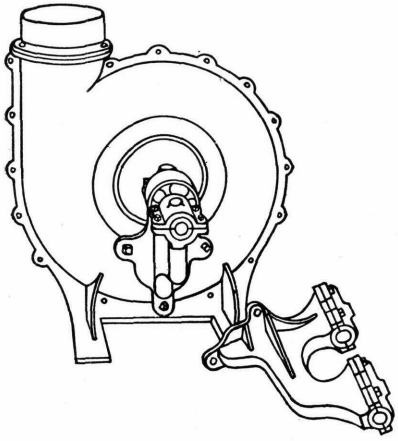

FIGURE 13.—Large metal fan for conveying the meal from the grinders to the cyclones.

from the cyclones if no collector is used. Collectors that are properly designed and installed will reduce the fire and explosion hazard.

Packers are used for packing the meal into sacks. Several makes are available on the market, all employing the same general principle. The meal is carried into the sack through a tube and is packed by means of a slowly revolving auger. Many of these packers are also equipped with automatic scales.

The conveyors are of the usual type of construction. Each well-equipped grinding plant has two sets, one for conveying the hay to the grinder and the other for conveying the sacked meal from the packers.

Most of the commercial mills that depend on the local supply of hay have several wagons and hayracks for hauling the alfalfa from the field to the mill, the number ranging from about 20 for a mill with a capacity of 4 tons per hour to double that number for the larger plants.

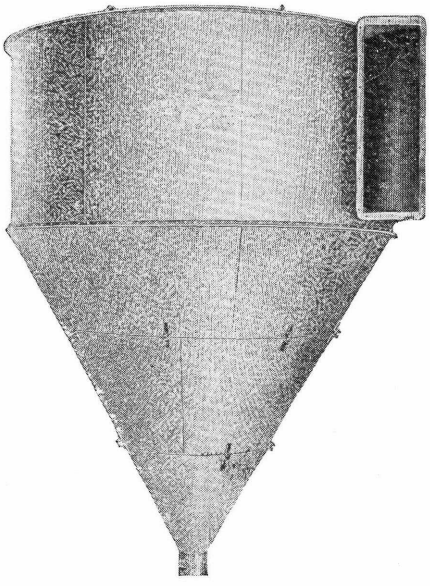

FIGURE 14.—A cyclone, or hollow metal cone, that serves to check the blast of air carrying the meal.

Other equipment consists of wagon scales for weighing the hay as it comes into the mill and small scales for weighing the bagged meal.

MAKING ALFALFA PRODUCTS

The first step in the manufacture of alfalfa meal is getting the hay to the mill. In those areas where loose hay is used, it is usually delivered to the mill by the farmer who produces the hay, the mills being located where they are readily accessible to the farmers. Usually the hay is brought into the mill as it is needed, although some mills have a shed where a small advance supply can be stored. A few of the mills have their own wagons and racks that can be used by the farmers delivering hay. In recent years considerable hay is delivered to the mills by trucks that are owned or hired by the mill. When the hay is hauled by truck it is bought in the stack on the basis of delivered weights. During the haying season some hay is hauled to the mill directly from the field, but the mills prefer to grind hay that has been in the stack or barn for a month to 6 weeks until it has gone through the sweat, after which it is more easily pulverized.

Hay containing more than 16 percent of moisture is difficult to grind and has a tendency to tear rather than break, with the result

that there is much fibrous material which, after sacking, tends to separate from the meal and collect in fiber balls in the top of the bag. This material does not mix well with other ingredients and, therefore, must be screened out.

Only a few mills grind baled hay. These mills are usually located at or near a large city where considerable quantities of alfalfa hay are available. Some mills are owned by hay dealers who store large quantities of alfalfa hay in their warehouses. The better hay is sold as baled hay and the less desirable is ground into meal.

The meal is taken from the grinder by suction produced by a fan and forced through a long galvanized tube to the cyclones. From the cyclones it goes to the packers, where it is put up in 100-pound bags. After being weighed, the bagged meal is loaded directly onto the car or is thrown on a conveyor which carries it to the warehouse, where it remains until marketed. If the warehouse is dry and the hay thoroughly cured before it is ground, there is little danger of spoilage, although losses occasionally occur when the material is shipped to damp climates.

The labor required for the different operations varies, but ordinarily a mill with a capacity of 4 to 5 tons of hay an hour will require five to six men.

The average grinding plant operates about 8 months, or during what is commonly spoken of as the alfalfa-milling season. Operations start in July, August, or September, depending somewhat on the season and the quantity of hay available, and continue until March, April, or May, when ordinarily the supply of hay is exhausted. Mills located at the big terminals, such as Kansas City, which depend on baled hay for grinding, operate as a rule throughout the year.

TYPES OF GROUND ALFALFA

Four types of ground alfalfa are produced at the present time. They are cut or chopped alfalfa, alfalfa meal, alfalfa-leaf meal, and alfalfa-stem meal. The Association of American Feed Control Officials has adopted the following as definitions for these four products:

Chopped alfalfa is the entire alfalfa hay, chopped and not ground finely enough to become a meal. It must not contain an admixture of alfalfa straw or other foreign material. (Adopted prior to 1928.)

Alfalfa meal is the product obtained from the grinding of the entire alfalfa hay, without the addition of any alfalfa stems, alfalfa straw, or foreign material; or the abstraction of leaves. It must be reasonably free from other crop plants and weeds and must not contain more than 33 percent of crude fiber. (Adopted in 1928.)

Alfalfa-leaf meal is the ground product consisting chiefly of leafy materials separated from alfalfa hay or meal. It must be reasonably free from other crop plants and weeds and must not contain more than 18 percent of crude fiber. (Adopted in 1938.)

Alfalfa-stem meal is the ground product remaining after the separation of the leafy material from alfalfa hay or meal. It must be reasonably free from other crop plants and weeds. (Adopted in 1928.)

Most of the States require that ground alfalfa meet these requirements in order to be sold in their respective States. A few of the States, however, have supplemented these definitions by requiring a minimum protein content for alfalfa meal and alfalfa-leaf meal.

The cut or chopped alfalfa is alfalfa that has been cut or chopped into about ¼-inch length and should not contain any fine particles.

The chopped material is screened to obtain a product uniform in texture and free of dust. This is used by the rabbit trade and is always sold unmixed. Usually the very best quality alfalfa is used for this purpose, as a good green product containing a high percentage of leaves is demanded.

A good idea of the quality of hay used in the production of chopped hay can be determined by an examination of the chopped material. This is not always possible when the hay has been ground into meal.

Alfalfa meal is produced by grinding the whole hay. The fineness varies from a coarse product, in which parts of the leaves and stems can be identified, to a very fine product in which the plant parts cannot be identified. The coarser meal is used in alfalfa-molasses feeds, whereas the finer meals are used in poultry, hog, and dairy feeds in which the alfalfa must be ground to about the same fineness as the other ingredients, in order to get a good blend and mixture. If the alfalfa meal is not fine, it tends to separate from the other ingredients of the mixture. The finer types of alfalfa meal are screened before being sacked, the portion that does not pass through the screen being returned to the grinder for further pulverizing.

Alfalfa-leaf meal is produced by separating the leaf from alfalfa hay or alfalfa meal. Very little if any alfalfa-leaf meal is produced by separating the leaves from the hay before it is ground, because no satisfactory machine has ever been developed for making such a separation. Leaves cannot be separated easily from the stems if the hay has been cured so as to retain most of the leaves. If the leaves have shattered badly in storing or baling they may be used for leaf meal by being separated from the stems before grinding. The common practice is to grind the whole hay and then separate the finer particles with a special screening device. In grinding, the leaves are more finely pulverized than the stems and can be separated to a large extent by screens, the leaf particles passing through and the stem particles passing over the end of the screen. The quantity taken out as leaf meal will depend on the leafiness of the original hay and can be regulated by changing the tilt of the screen.

The method used in manufacturing alfalfa-leaf meal results in a product that is uniform as to fineness. Most leaf meal is used in mixed poultry and hog feeds, where it must be as fine as other ingredients to keep it from separating when handled. Very little of this type of meal is fed unmixed. As it is an important source of vitamin A, some of the manufacturers buy it on the basis of its carotene or vitamin A content. Certain manufacturers produce a special alfalfa meal from which part of the stems have been removed, but which does not meet the requirements of alfalfa-leaf meal. This product is usually sold under some trade name that indicates that it is superior to the straight alfalfa meal. It also is used in poultry- and hog-feed mixtures.

Alfalfa-stem meal is the residue left after alfalfa-leaf meal or special alfalfa meal has been removed from the ground hay. It is usually a little coarser than the alfalfa-leaf meal from which it has been separated and is used in alfalfa and molasses mixtures and the cheaper grades of dairy feeds.

FEEDING GROUND ALFALFA

Various experiments have been made with alfalfa meal to determine its value for different kinds of livestock. These experiments have had two objectives—to determine whether it is more economical to feed alfalfa meal or alfalfa hay and to determine the value of alfalfa meal in replacing high-priced concentrates, particularly wheat bran.

In experiments comparing the value of alfalfa meal and wheat bran the agricultural experiment stations of Vermont, Massachusetts, and Pennsylvania have reached the same general conclusion—that alfalfa meal is slightly inferior to wheat bran for milk production. The results at the Nebraska station, on the other hand, indicated that the meal was fully equal to wheat bran. The former gave a slightly lower production of milk and butterfat, but this was offset by the gain in weight.

In feeding swine the Wyoming station found that alfalfa meal gave decidedly poorer results than middlings when fed with a corn ration, whereas the Colorado station concluded that although shorts and corn gave more rapid gains than alfalfa meal and corn, the latter was so much more economical that a farmer could afford to feed somewhat longer. In comparing alfalfa meal with alfalfa hay in a ration for fattening hogs, the Nebraska station concluded from experiments covering 5 years that alfalfa was more satisfactory if it was not cut or ground. The gains were more rapid and cheaper where the hay was fed from the racks. The Colorado and Kansas stations also found that in feeding hogs the grinding of alfalfa hay into meal did not increase its value sufficiently to pay for the extra expense. The New Jersey station found that alfalfa meal as compared with alfalfa hay in a ration for brood sows considerably reduced the cost of maintenance.

Poultry can utilize a small mixture of alfalfa meal in their daily mash to good advantage. In fact, many hens are fed alfalfa meal as the only source of carotene, in order to maintain a uniformly colored egg yolk. If hens are fed succulent green feed part of the year and alfalfa meal when green feed is not available, the color of the egg yolk will vary a great deal. The quantity of succulent green feed consumed cannot be as easily controlled as the quantity of alfalfa meal.

The mere grinding of alfalfa hay does not materially alter its composition, and that it has little effect on its feeding value is indicated by the results cited. The advantages of the meal are that it is fed with less waste than hay and is in a convenient form, especially for use in towns and cities. A considerable reduction on freight charges is obtained when it is shipped long distances.

ALFALFA MIXED FEEDS

Most of the alfalfa meal produced at the present time is used by the mixed-feed industry as one of the constituents of the various types of manufactured feed. These plants utilize a great variety of products, including the byproducts from the flour and feed mills, elevators, breweries, starch factories, etc., in addition to large quantities of corn, oats, and other feed grains. Alfalfa meal has come to occupy an important place as one of the constituents of mixed feeds, partly because

it is high in protein but principally because alfalfa having a bright-green color is usually high in carotene, one of the sources of vitamin A. In recent years farmers have shown a tendency to purchase a completely balanced ration, especially for poultry and hogs, and to a certain extent for dairy feeding. The mixed-feed industry has attempted to supply this demand with feeds containing all the elements necessary for proper growth, production, and reproduction of the animal. Alfalfa-leaf meal is an important ingredient in these feeds.

A survey of the ingredients used in mixed feeds indicates that some form of ground alfalfa is used in practically all poultry and hog feeds. Some manufacturers use alfalfa meal, some alfalfa-leaf meal, others dehydrated alfalfa meal, and a few dehydrated alfalfa-leaf meal. Mixed feeds containing alfalfa usually have from 5 to 7½ percent of alfalfa meal or alfalfa-leaf meal for poultry; from 5 to 10 percent of alfalfa meal for hogs; from 3 to 5 percent alfalfa-leaf meal or occasionally alfalfa meal for turkeys; and about 20 percent of alfalfa meal, or in a few cases dehydrated meal, for rabbits. Some manufacturers add about 2 percent of dehydrated alfalfa meal to their dog feeds. Ground alfalfa is used much less in dairy than in hog and poultry feeds, but when used alfalfa meal usually is preferred.

Where dairy farmers have home-grown feeds that are relatively low in protein they may purchase a protein supplement containing some alfalfa meal. This kind of feed is used to a greater extent for dairy cattle than for hogs or poultry. The simplest mixture and one that is used to a certain extent for both horses and cattle consists of alfalfa meal and molasses, the proportion of molasses ranging from 15 to 40 percent. Both sugarcane and beet molasses are used for mixing with alfalfa meal, the cane molasses being used wherever it can be bought as cheaply as or cheaper than the beet molasses. Sugarcane molasses is sweeter and seems to be more palatable, but the beet molasses carries a higher percentage of minerals, which some feeders consider an advantage, especially for cattle. This high mineral content also has a tendency to make the beet molasses more laxative than the cane molasses. The cane molasses has a tendency to darken the product more than beet molasses, so that it does not present quite so good an appearance on the market, which makes it less desirable commercially.

Alfalfa mixed feeds are now on the market in the form of pellets of various sizes, depending on the stock for which they are intended. Poultry pellets are usually half an inch in diameter and about one-fourth of an inch long. The principal advantage in pelleting feed is the reduction in waste under certain conditions. Waste is an important item in the feeding of range sheep and cattle when the feed is scattered on the ground.

Unfortunately, the chemical analyses of these mixed feeds are not a fair criterion of their feeding value, and, therefore, much depends on the honesty of the manufacturer and his desire to establish a reputable business. Reliable firms use only high-grade materials, their policy being to use ingredients that in themselves are palatable feeds; less reliable firms depend largely on the poorer quality of grain, alfalfa meal, and the sweepings from mills and elevators and make a product that is low in feeding value.

COMMERCIAL FEEDERS

In some of the Intermountain States, especially Utah and Idaho, several commercial sheep- and cattle-feeding concerns grind and use alfalfa meal, buying hay from the nearby growers and having it delivered to their feed yards and plant. These companies feed many cattle and sheep on contract and will mix and feed the kind of ration desired by the owner of the stock. Some of the hay may be fed to cattle without grinding, but all the hay is ground for feeding to sheep. Many sheep are brought to these places to be fed during the lambing season. Some of these mixing plants are located near sugar-beet factories, and the blackstrap molasses and beet pulp, which are byproducts from the beet industry, are used with alfalfa meal as the basis of the feeds.

DEHYDRATED ALFALFA

The United States Department of Agriculture probably inaugurated the first attempt at the artificial drying of forage crops in the United States in 1910. After the first attempt very little was done until

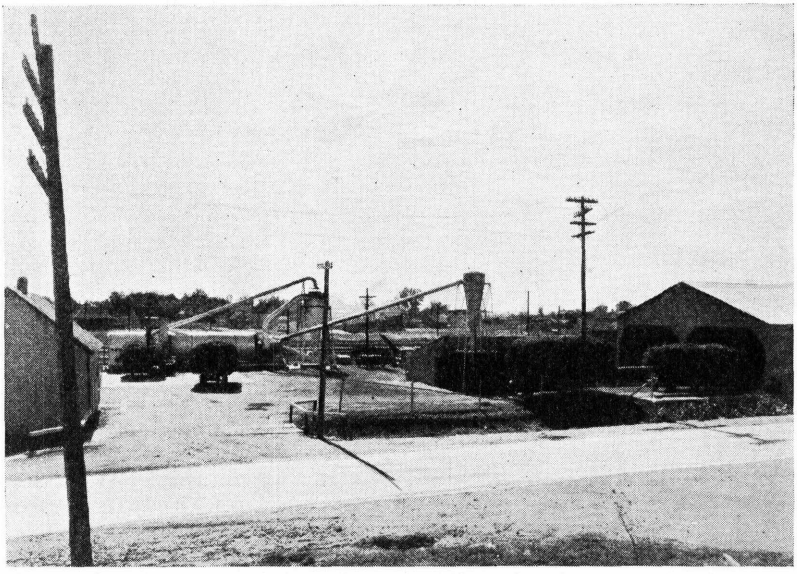

FIGURE 15.—Dehydrators are used to some extent in drying alfalfa, the resultant product being higher in carotene and protein than field-cured alfalfa.

about 1920, when a plant was erected in Louisiana. Active interest in drying alfalfa began about 1925, when several large dairies started to dry alfalfa as well as other forage crops for use as feed for their cattle, and by 1930 a number of driers were in operation. One of the common types of dehydrators is shown in figure 15. Artificially dried hay cannot be baled successfully, and since chopped hay can be dried more efficiently and with less mechanical difficulty than long hay, most of the driers in operation today chop the hay before it

FIGURE 16.—Pick-up cutter. This machine is being used for cutting green and cured alfalfa in the field.

enters the drier and grind it into meal after it passes through the drier. The pick-up cutter is used to some extent for this purpose (fig. 16). Under these conditions considerable saving in grinding results, as much less power is required for grinding artificially dried hay with 8 to 10 percent of moisture than sun-cured hay with 15 to 18 percent. The artificially dried meal is usually higher in feed value than sun-cured meal, owing to a higher protein and carotene content. The higher protein content is not the result of the method of drying, but is due to the fact that little, if any, leaf loss occurs during harvesting and drying. Because of its higher carotene and protein content, the mixed-feed manufacturers prefer dehydrated meal to sun-cured meal, especially for their better-quality feeds. Some of the feed manufacturers have drying plants in the surplus alfalfa-producing sections. At present most of the artificial drying plants are located in Michigan, Ohio, and Pennsylvania, although several are in operation in Kansas, Nebraska, and California.

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